

# Food biochemistry

From WikiEducator

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## Introduction

### Definitions

A few partial definitions of packaging are as follows:

1. A means for ensuring safe delivery of products to the consumer in sound condition at minimal cost.
2. An art, science, or technology required for preparing foods for transport, storage, or sales elsewhere from the point of production.
3. A technological and economic function aimed at minimizing costs of delivery while maximizing sales.

Packaging brings about protection of materials of all kinds by means of containers designed to isolate the contents to some known degree from outside influences. It is an indispensable aspect of food value addition.

## Nature of foods and food process classification

Foods are of animal (beef or eggs), plant (mango or wheat flour) or mineral (salt or water) origin, occurring as solids (roasted peanuts), liquids (milk), or semi-solids (ugali). They may be perishable (mangoes), non-perishable (dried grains), processed (cheese), minimally processed (pasteurized milk), or non-processed (fresh honey). In addition, foods may be intended for short-term preservation (fresh meat) or long-term preservation (UHT milk). All these factors will dictate the nature of packaging and storage conditions appropriate for the particular food.

## Why package foods

Packaging serves the following functions:

- Containment – enabling the food to be presented in a fixed measure by weight or volume of contents.
- Protection – against chemical and physical damage.
- Barrier – against transfer of oxygen, moisture, chemical compounds, and microorganisms that are detrimental to quality of food.
- Convenience – provides convenience in using the product. Also furnishes consumer convenience about microwavability, resealability, ease of opening, and reusability.
- Product information – conveys product information to the consumer, including description of food contents, weight/volume ratio, manufacturer's name, directions for use, sell-by date, and nutritional content.
- Marketing – serves as effective marketing tool for promoting product identification and sales
- Processing requirement – certain food processing operations demand specific product packaging to facilitate the processing (e.g. canning)
- Dispensing – certain packages facilitate dispensing of product (e.g. beer, salt, or soft drinks)

## Packaging materials

### Paper

Paper is a low cost, popular, readily available, and versatile packaging material. It accounts for about 50% of all packaging. Paper can be used as flexible pouches for primary packaging as well as more rigid outer secondary food packages. Flexible papers are used as overwraps, bags, or liners. Examples include Kraft paper, greaseproof paper, glassine, and waxed paper. Kraft paper is used for making paper sacks with capacities of even 50 kg for packaging dehydrated meat scraps, granulated sugar, dried grains (as multi-wall paper sacks) and powdered milk (laminated on the inside with plastics). Kraft paper is also used for making paperboard and boxboard cartons for secondary (outer) packaging. Polyethylene-coated Kraft papers are used for liquid packaging cartons and frozen food containers. Polyester-coated paper, capable of withstanding high temperatures, is used for ovenable or microwavable trays.

### Plastics

Plastics for food packaging are either commodity plastics or barrier plastics. Commodity plastics (e.g. polyethylene, polypropylene, polystyrene, and polyvinyl chloride) are low cost and have relatively poor oxygen barrier property. Barrier plastics (e.g. polyvinylidene chloride and ethylene-vinyl alcohol copolymer) are relatively expensive but exhibit much better oxygen barrier property. Polyethylene is the most popular plastic polymer in food packaging. There two types: low density polyethylene (LDPE) and high density polyethylene (HDPE). LDPE is transparent and softer (for film packaging as grocery sacks, shrink wrap films, and stretch wraps) , while HDPE is stiffer, harder, less transparent and, resistant to oils and greases, and more resistant to gas and vapor transmission (used milk bottles and breakfast cereal liners). Polypropylene (PP) also finds use in food packaging film wraps, containers, and closures. Biaxially oriented polypropylene (BOPP) is used for wrapping candies and sweets. PP is lighter than all other plastics. The major polyester for food packaging is polyethylene terephthalate (PET). Biaxially oriented PET films are used as components for boil-in-bag food packages and retortable pouches, vacuum packaging of cooked meat products, packaging of carbonated soft drinks and edible oils. Polyvinylidene chloride (PVdC), commonly known as saran, is used for packaging meat, sausage, fish, and cheese. Ethylene vinyl alcohol copolymer (EVOH) is used for making bottles for retortable food packages, tomato ketchup, mayonnaise, and jellies

## **Glass**

Glass is one of the oldest packaging materials. It was initially used for packaging wines. The use of glass for packaging heat-processed foods began in 1804. Glass is a desirable package for foods because it does not react with foods, has excellent barrier properties, transparent, reusable, reasonably strong, easy to open, can be moulded into any shape, and usable on many filling machines. However, glass is heavy, breakable, and susceptible to sudden temperature shocks. Plastics and laminates have largely overtaken glass in food packaging.

## **Metals**

Important metals for packaging foods include the sanitary tin can (for retortable packages) and aluminium (mainly as cans or flexible foil material). Aluminium cans are used mainly for beer and soft drinks packaging, while aluminium foils are used as laminates, retortable pouches, microwavable trays, and foil liddings.

## **Earthenware**

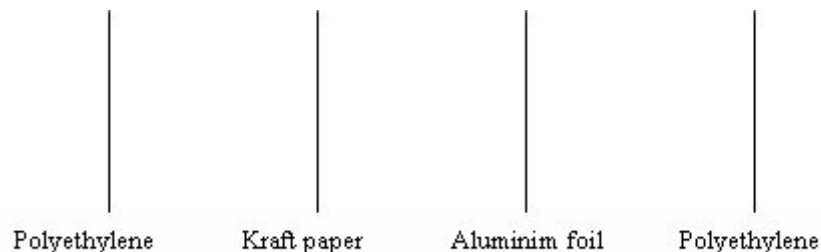
Earthen pots traditionally found extensive use as cooking vessels and for storage of water and fluid foods such as uji. However, weight, fragility, and low hygienic conditions are a drawback to their use.

## **Fiber/Textiles**

Sisal bags have been used extensively for packaging dried cereal and pulse grains, coffee, potatoes, sugar, and tea leaves (on transit to the factory). However, plastics bags (woven or moulded) are fast replacing sisal bags.

## **Composites/Laminates**

Lamination, either with metal foils or plastics (e.g. polyethylene), is intended to improve barrier and strength properties of packaging materials. As laminates, aluminium foil and polyethylene form part of the ubiquitous Tetrapak for dairy, fruit juice, and soft drinks packaging. A typical laminate may be as follows:



## Choosing a packaging material

### Mechanical properties

The packaging material must be strong enough to prevent physical damage to the food (e.g. bruising of fruits and vegetables and breakage of biscuits) and to other packaging materials (e.g. glass bottles in fiberboard containers).

### Physical properties

The packaging material must be able to protect the final physical nature of the food after processing as well as protect the environment around the food. To do this, the material must be able to control the movement of water, water vapor, oils and gases. It must also protect against UV-light and heat gains and losses where necessary.

### Chemical and biochemical properties

The package material must offer protection against chemical and biochemical spoilage by maintaining an environment around the food that reduces or prevents deteriorative chemical and biochemical spoilage reactions. Products of chemical deterioration must also not migrate into the food in any large quantities (e.g. corrosion of tin cans).

### Microbiological aspects

The packaging material must be able to protect the food and prevent contamination from external sources. The package environment should be able to slow or prevent the growth of undesirable microorganisms in or on the food by use of anaerobic conditions or inert gas atmosphere.

## **Insect and rodent infestation**

The package material must protect against insect and rodent infestation, particularly in bulk storage, in open warehouses, or where consumer storage conditions are likely to be inadequate. Paper may not be suitable here but laminates can provide the necessary protection.

## **Nature of the food to be packed**

- The package material must not contaminate the food by leakage or migration of toxic elements from it to the food.
- The final condition of the processed food will determine the nature of packaging material (is the food raw or fresh, is packaging required for processing, etc.).
- Susceptibility to microbial and insect attack and inherent flora will influence the nature of packaging material.
- If the food is still respiring or undergoing postmortem changes, the package material must be chosen to control the in-package changes.
- Many foods possess an odor or are susceptible to aroma loss or odor pick-up during storage. The packaging material must be selected to resist odors in the manufacturer stores and in the consumer's home environment.
- The packaging material must be easy to handle for rapid and uninterrupted production and should allow for easy retrieval of the food by the consumer.

## **Availability & cost**

The package material must be easily available at a reasonable cost.

## **Food spoilage and deterioration**

In packaged foods, the way in which the food deteriorates should be known and the influence of transport, storage, and sales condition on the rate at which this deterioration takes place must be estimated.

## **Agents of deterioration**

Bacteria, moulds, insects, birds, and rodents cause biological deterioration of foods. Moisture and temperature affect spoilage by bacteria and moulds. Insects, birds, rats, and mice cause damage to stored and packaged products. Natural aging processes such as senescence also cause product deterioration.

## **Conditions for growth**

All microorganisms require moisture for growth. The amount of available moisture for microbial activity is expressed in terms of the water activity,  $a_w$ . The higher the  $a_w$ , the greater the microbial growth and spoilage. The pH also influences bacterial growth as is temperature and aeration. Generally, microorganisms can grow from  $-10$  to  $80^\circ\text{C}$ . Aerobes require oxygen for their growth, anaerobes do not, while facultative anaerobes will grow both in the presence and in absence of oxygen.

## Food spoilage bacteria

### Lactic acid bacteria

These are facultative anaerobes requiring sugar for growth with consequent production of lactic acid, which may change the smell and taste of the food. Formation of lactic acid may or may not be desirable depending on the particular food.

### Acetic acid bacteria

These are aerobic, develop in alcohol-containing foods to produce acetic acid, which affects the smell and gives a sour or acid taste to the food.

### Proteolytic bacteria

These develop in non-acid protein foods producing toxins harmful to humans. Unpleasant gases are also formed. The food becomes sticky and slimy. Examples of proteolytic bacteria are *Clostridium botulinum*, *Clostridium perfringens*, *Bacillus cereus*, *Salmonella typhimurium*, *Listeria monocytogenes*, *Campylobacter jejuni*, and *Staphylococcus aureus*.

### Moulds and yeasts

These are aerobic spore formers. Examples are *Penicillium* (green moulds) and *Aspergillus* (black moulds). They need starch, proteins, and high moisture (80 – 90%RH). Yeasts prefer acid sugar-containing foods from which they produce alcohol by fermentation.

To control microorganisms, the packaging material should be water-resistant. Oxygen scavengers may be put in package to discourage aerobic spoilage organisms. Insect infestation can be prevented by cleanliness and storage in cool, dry and well-ventilated premises. In addition, thicker and stronger packaging material with smooth surfaces may be used. Insect repellents may also be used. Good housekeeping generally prevents rodents and birds.

## Shelf-life of packaged food products

Shelf life is the period during which a packaged product maintains marketable or acceptable quality under specific storage conditions. The shelf life of a product depends on the following:

- Initial quality of the food product
- Amount of quality change that can be allowed
- Prevailing environmental conditions
- Barrier properties of the packaging material
- Compatibility between food product and package

## Information for determination of shelf life

- Stability of food product and optimal conditions for storing it
- The external environmental conditions to which the package is to be exposed
- The size of the package, kind of package and thickness of the packaging material that can maintain the internal environment at the optimal conditions.
- The marketing and distribution requirements

## How to determine the shelf life of packaged food products

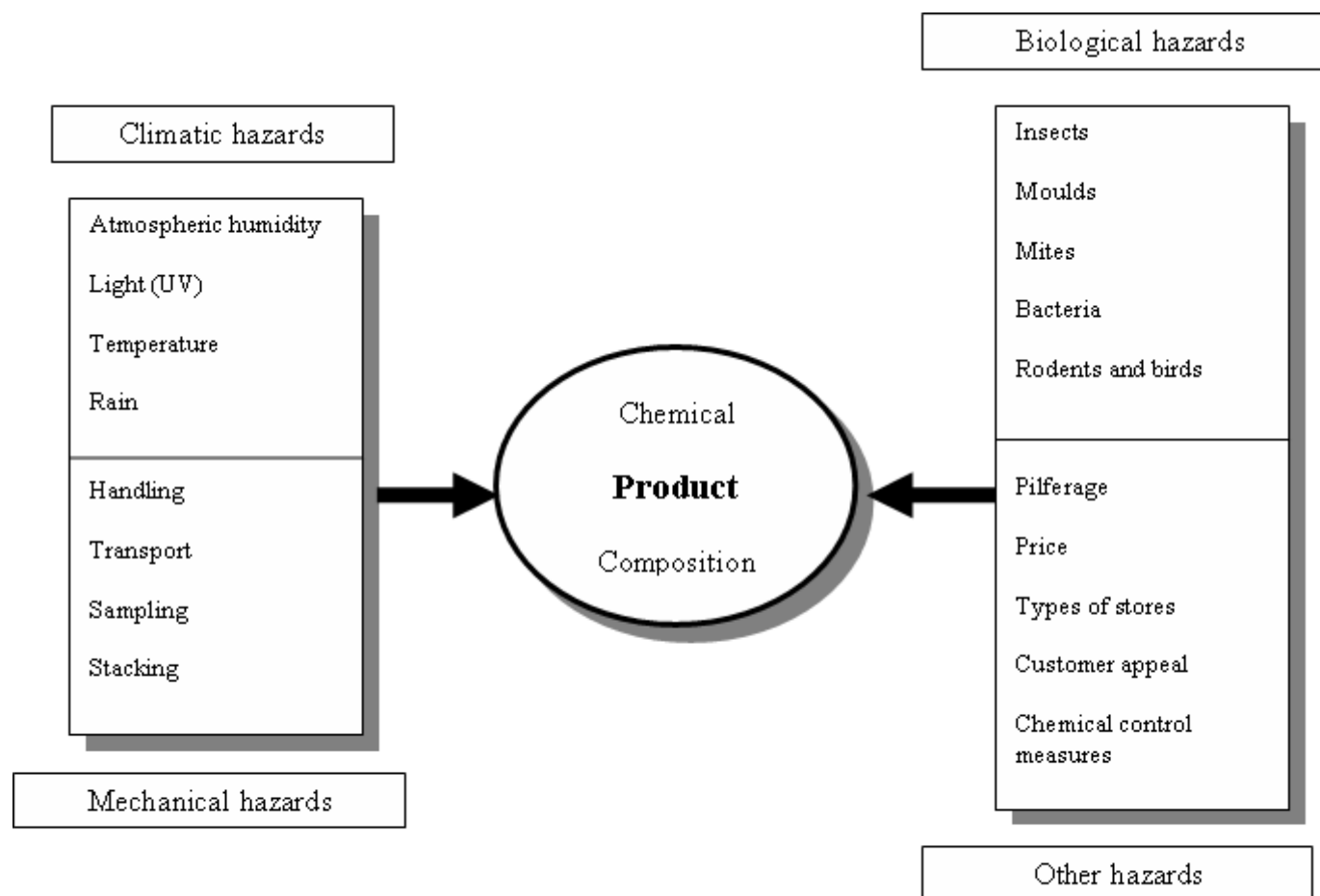
### Actual storage tests

The packaged product is subjected to a storage regime simulating the actual marketing and distribution conditions and the product failure rate is monitored with time. For some products, this method may require a very long time.

### Accelerated storage tests

At elevated temperature and moisture content, product deterioration rate can be enhanced to suitably shorten the testing duration. Techniques for non-isothermal (varying temperature) storage stability studies can be employed to simulate actual environmental variations during marketing and storage. The temperature dependence of product deterioration indices is often presumed to obey Arrhenius kinetics.

## Hazards during transport and storage of foods



**Fig. 1: Hazards during distribution and storage**

## Principles of package development

The packaging for your competitor's product in the market may not be the best or optimum package design, but it is a good starting point for developing the package of your own product. To ensure successful package development, the following should be considered:

- Product assessment
- Hazards of distribution (mechanical, climatic, biological, etc.)
- Marketing requirements (competitors, retail service, customer, convenience, etc.)
- Selection of packaging material and packaging machinery

The essential point in developing or choosing an optimal package for your product is that you should know your product well (in terms of its life cycle, physical, chemical and microbiological characteristics, major spoilage parameters, hazards of distribution, etc).

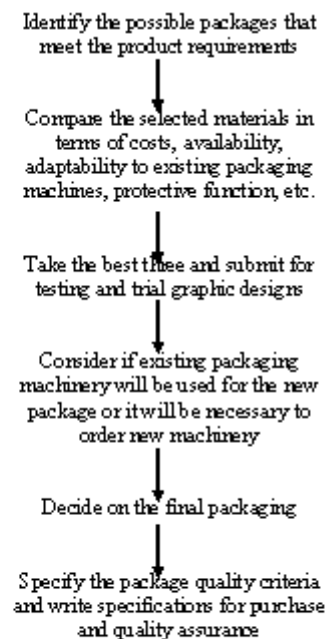
One should determine when to change a package, why change the package, and how to change the package. When to change a package is dictated by the life cycle of the product. The stages in the life cycle of a product are as follows (see figure provided):

- Introduction
- Growth
- Maturity
- Obsolescence

When introducing a new food product to the market, the packaging should be just right. Particular attention should be focused on the design and convenience features of the package. This will help the product to take off successfully. Subsequently, when sales begin to fall off during product maturity, design of new packages can help generate a new image and increased sales. Other reasons for changing a package may be as follows:

- To reduce unit costs
- Promote wholesale, retail, and/or consumer acceptance of the product
- Improve shelf life
- Increase turnover, sales and profits
- Provide customers with better method of using the product
- Improve handling in transport or retail outlet

How to change the package may be illustrated as shown in Figure 2. Developing a product package can be very involving and the entrepreneur may have to engage consultants such as food technologists, graphic designers, engineers, and manufacturers for packaging materials and machinery. All this may seem an enormous task, but it is better to take your time and get things right the first time rather than rush to introduce a product that is destined for failure.



**Figure 3: Package development process**

## Levels of packaging

The primary package holds the basic product. It may be a bag, can, carton, bottle, tube, sachet, or other form of container. If such small primary packages are to be distributed in large quantities, it is necessary to group them together in a larger package called a secondary package. A corrugated fiber board carton holding several units of canned fruit is an example of secondary packaging. It is often necessary to group secondary packages together in pallets to facilitate materials handling equipment in warehouses and loading in or out of trucks and ships. This forms a tertiary package.

primary



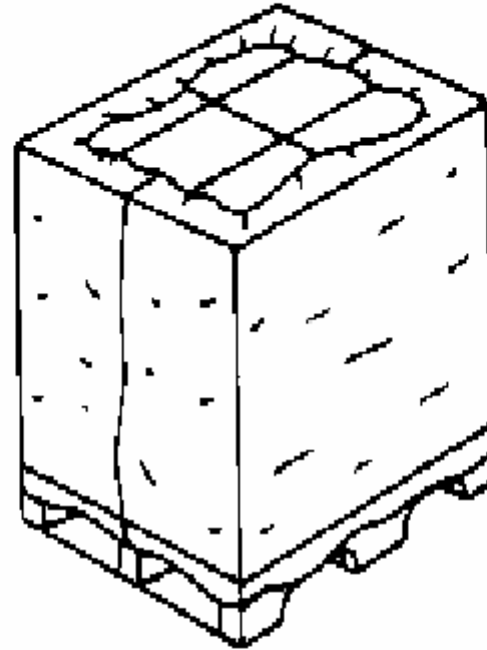
cartons

secondary



shipping  
container

tertiary



unit load

# Aspects of packaging legislation

Since packaging is virtually unavoidable in commercial food vending, it is important to know the legal requirements for packaging to avoid clashing with the law and to ensure consumer confidence. Legislative guidelines for local packaging requirements are elaborated by the *Technical Committee 05/TC 05* (concerned with labeling of prepackaged foods) of the Kenya Bureau of Standards (KEBS). This Committee has developed standard *KS 05-40 of 1990*, which is in two parts. Part I is concerned with 'General requirements for labeling of prepackaged foods for human consumption'. Part II deals with 'Guidelines for date marking'. These packaging standards are available at the KEBS Library (off Mombasa Road) for reference or purchase by any interested party.

## General Provisions in KS 05-40: Part I

### General Requirements

- All prepackaged foods must have a label clearly legible, indelible, conspicuous, and prominently displayed on container.
- The label shall not be deceptive, false, misleading, or likely to create an erroneous impression regarding character in any respect
- The label shall remain firmly attached to the container under expected storage conditions until the product reaches the consumer
- The label information shall not be placed at the bottom of the food container
- Additional words (next to name of the food) should be included to avoid misleading or confusing the consumer about the true nature and physical condition of the food including type of packaging medium, style, condition or type of treatment it has undergone e.g. dried, concentrated, reconstituted, or smoked.
- Labels on prepackaged foods shall bear the following information applicable to the food being labeled:

### Labeling Requirements on Main Panel of a Prepackaged Food

Labeling requirements on main label shall be:

1. The brand name or trade name of the food product
2. The common name of the food
  - Common names shall indicate the true nature of the food:
  - Near the common name, a correct declaration of the net contents in metric units according to Weights and Measures Rule 1971; Cap. 513 of the Weights and Measures Act
  - Foods packaged in liquid media (water, aqueous solutions of sugar or salt, fruit and vegetable juices in canned fruits and vegetables only or in combination with vinegar) shall carry a declaration in the metric system of the drained weight.
3. List of ingredients
  - Grouped together on any panel, every product shall be a label declaring on one place a complete list of ingredients, excluding water, in descending order of proportion by mass, except:
  - In dehydrated foods intended to be reconstituted by adding water. In such as case, list the ingredients and add, "Ingredients when Reconstituted"
  - In case of foods of a single ingredient

4. Storage conditions - Instructions for the proper storage of the products, if different from normal ambient conditions, shall be declared.
5. Name and address – The name and address of one or more of the following shall be declared on the label, together with an indication of the capacity in which he has acted:
  - Manufacturer
  - Packer
  - Distributor
  - Importer
  - Vendor
6. Country of manufacture – shall be declared unless already stated above
7. Irradiated food – if food is irradiated, it shall be declared on the label
8. Grading – grade designations on label shall be readily understood and not misleading or deceptive
9. The declaration, “Made in Kenya” or “Produce of Kenya”

### **Labeling Requirements for Special Dietary Foods**

All dietary foods shall bear all the information under “General Requirements” and “Labeling Requirements on Main Panel of a Prepackaged Food” above and the following:

1. Where a statement or claim implying a special dietary use is made on the label of any food, the label shall carry a statement of the type of diet for which the food is recommended.
2. No person shall sell a food containing a non-nutritive sweetening agent unless the label carries a statement indicating a special dietary use.
3. Artificial sweetener – A food containing saccharin or its salts shall carry on the label a statement to the effect that it contains a non-nutritive artificial sweetener.
4. Carbohydrates or sugar reduced foods – A special dietary food recommended for carbohydrates or sugar reduced diets shall be a food that contains not more than 50% of the glycogenic carbohydrates normally in foods of the same class
5. A food may be described as sugarless, sugar-free, low carbohydrate or by any other synonymous terms if it contains not more than 0.25% glycogenic carbohydrates.
6. Where a statement or claim relating to the carbohydrate, sugar, or starch content is made on the label of the food, the label shall carry a statement of the carbohydrate content in grams per 100g.
7. Reduced calorie foods:
  - Special dietary foods recommended for calorie reduced diets shall be foods that contain not more than 50% of the total calories normally present in foods of the same class.
  - A food may be described as low calorie if it contains:
    - 15 calories per average serving
    - 30 calories in a reasonable daily intake
  - Where a statement or claim relating to the calorie content is made on the label of a food, the label shall carry a statement of the calorie content in calories per 100g.
8. Sodium reduced foods:
  - The number of milligrams of sodium contributed by a reasonable daily intake of a special dietary food recommended for a sodium-reduced diet shall not exceed 1/6 the number of milligrams of sodium contained in a reasonable intake of the same food.

- A food may be described as 'low sodium' if it contains not more than:
  - 10 mg sodium in an average serving
  - 20 mg sodium in a reasonable daily intake
- Where a statement or claim relating to the sodium content is made on the label of a food, the label shall carry a declaration of the sodium content in mg per 100g.
- Small packages: Where the container is too small to reasonably bear all the information required by this standard, the outer package shall be labeled according to this Standard and shall be available for consumer's inspection when required.

9. Presentation of mandatory information:

- Statements required to appear on the label by virtue of this standard or any other Kenya Standard shall be clear, prominent, indelible, and readily legible to the consumer under normal conditions of purchase and use. Such information shall not be obscured by designs or other written, printed, or graphic matter and shall be in a contrasting color to that of the background.
- The letters in the name of the food shall be in size reasonably related to the most prominent printed matter on the label. Where the container is covered by a wrapper, the wrapper shall carry the necessary information, or the label on the container shall be readily legible through the outer wrapper or not obscured by it.
- In general, the name and net contents of the food shall appear on that portion of the label normally intended to be presented to the consumer at the time of sale.
- Statements required to appear on the label by virtue of this standard or any other KS shall be in English. If imported goods are not already in English, a supplementary label shall be used to declare the mandatory information in English.

## General Provisions in KS 05-40: Part II

### Section 1: Guidelines for Date Marking

Date marking is to give the consumer a date for ascertaining the status of product wholesomeness under specified storage conditions. The following dates may be printed on the product label:

1. Date of Manufacture – The date on which the food becomes the product as described
2. Date of Packaging – The date on which the food is placed in the immediate container in which it will be ultimately sold. Date of manufacture and date of packaging may be the same.
3. Sell-by Date – The last date of offer for retail sale after which there remains a reasonable storage period in the home.
4. Date of Minimum Durability (Best Before Date) – This signifies the end of the period under any stated storage conditions during which the product will remain fully marketable and will retain any specific qualities for which tacit or express claims have been made.
5. Use-by Date (Expiry Date) – The date which signifies the end of the estimated period under any stated storage conditions, after which the product probably will not have the quality attributes normally expected by the consumers. After the date, the food should not be regarded as marketable.
6. Storage instructions – In addition to date, any special conditions for the storage of food shall be indicated if the validity of the date depends thereon.
7. The following products (Table 2) shall bear prominently:
  - A date marking, showing the last day, month, and year on which the product may be sold
  - The proper storage conditions

**Table 1: Products for Date Marking**

Packed UHT liquid milk, fermented milk, yoghurt, and cream; canned liquid evaporated milk; packed and canned butter; canned condensed milk; packed and canned milk powder; canned ghee; all prepackaged baby foods; prepackaged cereal flours; pasta products; biscuits and cookies; cakes; breakfast cereals; flavored and mixed spices; canned and packed vegetables and fruits; bottled and packed tomato sauce, ketchup, puree, juice, whole tomatoes; chilli sauce, mayonnaise; packed dehydrated fruits and vegetables; canned and packed fats and oils; margarine; bottled drinks, squash, juices; bottled or canned beer, cider, sherry; non-alcoholic beverages; canned meat and fish; githeri; sausages; chocolate and confectionery; cheese; jams, marmalade, jellies; honey; fried peanuts and crisps; bread and cakes; tea; coffee.

**Section 2: Guidelines for Nutritional Labeling****Purpose**

1. To ensure that nutrition labeling is effective by:
  - Providing the consumer with information about a food so that a wise choice of food can be made
  - Encouraging the use of sound nutritional principles in the formulation of foods which benefit public health
  - Providing a means for conveying information on the nutrient content of a food on the label
  - Providing the opportunity to include supplementary nutrition information on the label
  - To ensure that nutrition labeling does not describe a product or present information about it which is in any way false, misleading, deceptive, or insignificant in any manner.
  - To ensure that no nutritional claims are made without nutrition labeling

**Principles of nutrition labeling**

1. Nutrient declaration – this entails a suitable profile of nutrients in the food of nutritional significance. This is to convey an understanding of the quality of nutrients contained in the product.
2. Supplementary nutrition information – content of supplementary nutritional information will vary from one target population group to another according to the educational policy of the country and the needs of the target groups.
3. Nutrition labeling – should not deliberately imply that a food which carries such labeling has necessarily any nutritional advantage over a food which is not so labeled.
4. The following definitions apply:
  - Nutritional labeling – is a description intended to inform the consumer of nutritional properties of a food
  - The components of nutritional labeling are: Nutrient declaration and Supplementary Nutrition Information
  - Nutrition declaration – means a standardized statement or listing of the nutrient content of a food.
  - Nutrition claim – is any representation which states, suggests, implies that a food has particular nutritional properties including but not limited to the energy value and to the content of protein, fat, carbohydrates, as well as the content of vitamins and minerals. The following

do not constitute nutrition claims:

- Mention of substances in the list of ingredients
- Mention of nutrients as a mandatory part of nutrition labeling
- Quantitative or qualitative declaration of certain nutrients or ingredients on the label if required by a national standard
- Nutrient – is any substance normally consumed as a constituent of food:
  - Which provides energy
  - Needed for growth, development, and maintenance of life
  - A deficit of which will cause characteristic biochemical or physiological changes to occur
- Sugars refer to mono- and di-saccharides in foods
- Dietary fiber – the edible plant material not hydrolyzed by endogenous enzymes of the human digestive tract as determined by the agreed upon method
- Polyunsaturated fatty acids – are fatty acids with cis-cis methylene interrupted double bonds
- Nutrient declaration:
  - Is mandatory for foods for which nutrition claims are made
  - Shall be voluntary for all other foods
  - Where nutrient declaration applies, the declaration of the following is mandatory:
    1. Energy value
    2. Amount of protein, carbohydrates, and fat
    3. Amount of any other nutrient for which a nutrition claim is made
    4. The amount of any other nutrient considered to be relevant for maintaining a nutritional status
  - In case of claims with respect to amount or type of carbohydrates, the total sugars should be listed in addition to the above declarations.
    1. Amount of starch or other carbohydrates shall also be listed
    2. In case of dietary fiber claim, the amount of dietary fiber shall be declared
  - In case of fatty acid claims, the amounts of saturated fatty acids and polyunsaturated fatty acids shall be declared
  - Vitamins and minerals may be listed as follows:
    - Only vitamins and minerals for which recommended intakes have been established and/or which are of nutritional importance shall also be declared.
    - Only those vitamins and minerals in significant amounts shall be declared.
  - Calculation of nutrients:
    1. Calculation of energy:
      - Carbohydrates, 4 kCal/g – 17 kJ
      - Proteins, 4 kCal/g – 17 kJ
      - Fat, 9 kCal/g – 37 kJ
      - Ethanol, 7 kCal/g – 29 kJ
      - Organic acids, 3 kCal/g – 13 kJ
    - Calculation of protein:
      1. The amount of protein to be listed should be calculated using the formula:  $\text{Protein} = \text{Total Kjeldhal N} \times 6.25$ .
  - Presentation of nutrient content
    - Nutrient content declaration shall be numerical

- Information on energy value shall be in kJ or kCal per 100 g or per 100 mL or per package, if package contains only a single portion; or per serving.
- Carbohydrates, proteins, and fat shall be expressed in g per 100 g or g per 100 mL or g per package.
- Numerical information on vitamins and minerals shall be in metric units and/or as a percentage of the Reference RDA per 100 g or per package or per serving.
- Information on energy value and protein may also be expressed as a percentage of Reference RDA. RDAs should be based on nutrient intakes recommended by FAO/WHO.
- The following shall be used as the Reference RDA for labeling purposes:
  1. Energy, MJ (kCal) 9.5 (2300)
  2. Protein, g 50
  3. Vitamin A, µg 1000
  4. Vitamin D, µg 5
  5. Vitamin E, µg 10
  6. Vitamin C, mg 60
  7. Thiamin, mg 1.4
  8. Riboflavin, mg 1.6
  9. Niacin, mg 18
  10. Vitamin B6, mg 2
  11. Folic acid, µg 400
  12. Vitamin B12, µg 3
  13. Calcium, mg 800
  14. Phosphorus, mg 800
  15. Iron, mg 14
  16. Magnesium, mg 300
  17. Zinc, mg 15
  18. Iodine, µg 150
  19. Presence of carbohydrates shall be declared on the label as 'carbohydrates'. Where the types of carbohydrates is declared, this should be indicated thus: 'Carbohydrates....g. of which sugars...g.'
  20. Declaration of fat should be: 'Fat, of which polyunsaturated fatty acids...g, and unsaturated fatty acids...g'.
- Tolerances and Compliance
  1. Tolerance intervals shall be set in relation to public health concerns, shelf-life, accuracy of analysis, processing variability.....according to whether the nutrient in the product is added or naturally occurring.
  2. Values in nutrient declaration shall be weighed average values derived from data specifically obtained from analyses of products representative of the product being labeled.
  3. Where a product is subject to a Kenya Standard, the specifications in that Standard take precedence.
- Supplementary nutrition information
  1. The purpose of supplementary nutrition information is to increase the consumer's understanding of the nutritional value of the food and assist in interpreting the nutrient declaration
  2. Optional except in nutrient declaration

## Section 3: General Guidelines for Claims

1. A claim is any representation which states, suggests, or implies that a food has particular qualities relating to its origin, nutritional properties, nature, processing, composition, or nay other quality.
2. Prohibited claims:
  - Claims of measurable and objective characteristics that cannot be substantiated.
  - Claims suggesting that adequate quantities of nutritious substances contained in the product cannot be obtained from a balanced everyday diet.
  - Claims that a common food contains adequate quantities of all essential nutrients, unless authorized by the rules in force.
  - Recommendations by medical professionals, authorities or other competent bodies in the public health field and testimonials connecting nutrition and health.
  - Claims that exploit or arouse fear or anxiety or discredit other foods whether of a similar nature or not.
  - Claims that a food has become nutritious from the addition of substances added for technical and/or organoleptic reasons.
  - References to doctors, pharmacists, medical instruments, the human body or organs, even if presented in a stylized manner, intended to illustrate a physiological function.

## Summary of Labeling

All package labels must declare the following information:

1. The name of the product
2. The list of ingredients and components
3. The net quality
4. The date of minimum duration
5. Any special storage conditions
6. Name and address of manufacturer, packer or distributor
7. Particulars of the place of origin (export goods)
8. Instructions for use

## Cost of packaging and product pricing

Packaging is a necessary evil. The necessity has to do with the fact that a package is unavoidable in modern-day value addition of foods, while the evil is in the cost, which can be quite substantial depending on the type of food and package.

The factors affecting overall package costs are as follows:

1. Package development costs – the desired package has to be defined, conceptualized, designed (function and graphics), pilot produced, market tested, validated, and, finally, launched. All these developmental stages will cost money.
2. One-time costs – this entails tooling costs for production e.g. dies, moulds, packaging line equipment, etc.

3. Materials costs – involve purchase of materials required for retail, primary, secondary, and tertiary packaging
4. Packaging machinery and process costs – this includes purchase or hire of packaging machinery, depreciation costs on machinery, and labor costs.
5. Storage and distribution costs, including insurance.

The product manufacturer may get a packaging supplier to develop a new package, but he must first define the package requirements and finally pay the package development cost in the price of the package. Ultimately, the consumer controls the price of the product. The food product manufacturer can know what the customer is ready to buy by conducting a market research. If the cost of packaging is relatively small in comparison to the ex-factory price of the product, good profits and marketing advantage are possible. The package developer must produce packages at the lowest possible prices.

Where alternative packages exist for a product, the product manufacturer can opt for the cheapest alternative, depending on availability of packaging machinery and production scale. For example, yogurt can be packaged in gable top TetraBrik, PET bottles, polyethylene-laminated Kraft paper, or bottles. TetraBrik and laminated Kraft paper require elaborate machinery and are suitable for large-scale continuous processing facilities with large product throughput. Small-scale, batch-processed yogurt may be conveniently packaged in PET bottles.

Table 2: Typical Plastic Package Costs for Some Prepackaged Kenyan Foods

| Product                 | Capacity | Cost of package (KShs) | Sale price (KShs) | % Package cost |
|-------------------------|----------|------------------------|-------------------|----------------|
| Mala Flavoured yogurt   | 25 mL    | 3.50                   | 5.40              | 8.80           |
|                         | 500 mL   | 25                     | 50                | 110            |
|                         | 1100 mL  | 14                     | 10.8              | 8              |
| Fruit juice concentrate | 5 L      | 25                     | 1500              | 1.67           |

Tomato paste 400 mL 5.50 35 15.71

Fruit jam 500 mL 8.50 65 13.08

Marmalade 500 mL 8.50 80 10.63

## Part II: Applications

### Packaging of specific food products

#### Respiring fruits and vegetables

- Examples are kales, cabbage, tomatoes, mangoes, bananas, potatoes, and onions.
- Packaging materials should be permeable to gas movement in and out of package. This is because fresh fruits and vegetables are still respiring and the internal atmosphere will alter reducing the O<sub>2</sub> quantity leading to anaerobiosis and consequent product spoilage.
- The following flexible film materials may be used:
  - Cellulose acetate
  - Lacquered cellulose
  - PVC
  - Lacquered orientated cellulose

- Ventilation (goring of small holes on the surface of the packaging material) may be necessary to increase gas permeability.
- Larger or heavier quantities (>50kg) are usually packaged in the following materials:
  - Multi-wall Kraft paper sacks laminated or lacquered on the inside to allow gas permeation but reduce water loss
  - Inside the multi-wall Kraft paper may be lined with jute and then waxed.
  - Fibreboard cartons or boxes with partitions for individual items may also be used.
  - Molded pulp or plastic foam containers (coupled with shrink-wrapping) may also be used.

## Fresh meat

- Drying or moisture escape should be prevented but O<sub>2</sub> should be allowed.
- Use MSADT cellulose film with coating on the outside for moisture proofing. This affords protection for about 2 – 4 days.
- When the cellulose is wet, O<sub>2</sub> can pass through but water is prevented.
- For longer periods, use PVC or polythene packs, laminates, or aluminum foil; but these are O<sub>2</sub> impermeable so colour of meat may fade to brown.
- On opening and storage at cool temperatures for 1 – 2 weeks, the real colour is restored.
- Use of O<sub>2</sub> impermeable materials may encourage the growth of microorganisms such as *C. botulinum*, which prefers anaerobic conditions.

## Pasteurized products

- These require only a limited shelf life.
- The products in this category are usually heat-treated at less than 100°C to destroy pathogens but not spoilage microorganisms.
- The products may be heat processed and then aseptically transferred into suitable packages or the pasteurization process may be in-package. In-package pasteurization requires packaging materials that can withstand the required process temperatures (e.g. glass) for liquid foods (beer, milk, etc.).
- Wax-coated paper cartons laminated with aluminum foil or polythene on the product side can also be used.
- Tetra-pak systems also find widespread use. These are heat-sealable and easily adaptable to continuous and aseptic filling.

## Dehydrated (dried) foods

- These have low moisture contents (1 – 20%). Dried foods have aw below that at which most microorganisms can grow.
- Drying achieves reduction in weight and volume hence facilitating transport and storage. Drying is achieved by sun or air-drying, mechanical drying, spray drying, freeze-drying or vacuum drying. Dried foods can be categorized into the following groups:

Table 3: Moisture Content of Various Foods

| Product | Capacity | Cost of package   |
|---------|----------|---|
|         |          | Moisture content (%) Examples Group 1 1 - 3 Tea, coffee Group 2 2 - 8 Dehydrated vegetables, herbs, spices, dried fish, breakfast cereals Group 3 6 - 30 Cereals and cereal products, pulses, oil seeds Group 4 25 - 40 Jams, jellies, fruits, nectars, sugar confectionery |

- Dried foods are susceptible to non-enzymatic browning and oxidative changes. Addition of SO<sub>2</sub> can reduce these changes. The aim of packaging should be to:
  - Prevent moisture transfer
  - Prevent O<sub>2</sub> and SO<sub>2</sub> permeation
- Oxygen scavengers can be used for dried and O<sub>2</sub> sensitive foods. For example, the shelf life of white bread in polypropylene film can be extended from by over two weeks at room temperature by incorporating an O<sub>2</sub> absorbent into the package. Examples of oxygen scavengers are finely divided iron powder contained in a sachet highly permeable to O<sub>2</sub> and water, glucose oxidase enzyme, Iron II carbonate, and platinum catalyst. Use of oxygen scavengers is an example of 'Active Packaging System'.

**Table 4: Packaging Materials for Various Groups of Dried Foods**

| Group   | Mode of deterioration                      | Packaging materials  |
|---------|--|--|
| Group 1 | Hygroscopic, moisture uptake               | Materials impermeable to O <sub>2</sub> and H <sub>2</sub> O e.g. glass jars hermetically sealed with Al foil under cap, cans, heat sealable multi-wall laminates with Al foil layer, packing in vacuum. |
| Group 2 | H <sub>2</sub> O uptake                    | Triple laminates of polyethylene/Al foil/paper, cans with re-sealable lids, paper sacks lined with polyethylene liners, Al cans, heat sealable Al foil/paper laminates.                                  |
| Group 3 | H <sub>2</sub> O uptake, moulds, aflatoxin | Sacks, silos, paper/plastic laminates, paperboard drums, laminated bags, or sachets, plastic containers.   |
| Group 4 | Yeasts, moulds                             | Glass jars, cans, pottery, and plastic containers.   |

**Table 5: Packaging of Specific Dried Products**

| Product                      | Moisture content (%)                       | Package materials  |
|------------------------------|--|--|
| Dried fruits                 | 15 – 20 (less tendency of moisture uptake) | To provide mechanical protection and protection against insects and rodents.   |
| Air dried vegetables         | 4 - 7                                      | Heavier gauge film with moisture proof (MSAT regenerated celluloses).  |
| Dried powders (milk, coffee) | 1 - 2                                      | Package against O <sub>2</sub> and H <sub>2</sub> O uptake in tin cans, Al cans, laminates, and PVC. Use of in-package dessicants e.g. silica gel, CaCl <sub>2</sub> , allumina recommended. |

NB: MSAT: M – moisture proof, S – heat sealable, A – coating anchored to the cellulose, T – transparent

### Sugar confectionery

- These include boiled sweets and toffees, which tend to absorb moisture from the atmosphere.
- Usually wrapped individually in moisture-proof cellulose films, Al foil, and coloured or plain cellulose films.
- May be further wrapped in MSAT cellulose film plus paperboard cartons, glass jars, tins as final outer containers to prevent moisture absorption during long-term storage.
- Chocolate and milk are susceptible to heat and light but not to oxidation. Packaging must prevent water absorption by sugar in the chocolate causing 'bloom'.
- Wrapped in Al foil heat sealable with glassine over wrap followed by simple bleached Kraft paper for printing purposes.
- PVC trays have also been used.

Dairy products Packaging for some common dairy products are given in Table 5. Table 6: Packaging of Dairy Products Product Packaging Butter Wrapped in greaseproof paper, vegetable parchment, or laminated foil, tin cans, PVC tubs, and laminates (Polythene/Al foil sachets). Cream Packaged in wax coated paperboard containers with replaceable lids for refrigerated storage, plastic containers with press-on or screw type lids. Cheese Moisture proof cellulose (MSAT) for up to 5 days, vacuum packed into flexible low water permeable laminates or tight wrap Al foils. Sterilized and evaporated milk Metal cans and glass bottles

### Beer and soft drinks

- Beer is usually packed in glass. The bottle is usually brown or amber for protection against UV light.
- The bottle should withstand the pressurized effects of CO<sub>2</sub>
- Strong cans (Al or Tin) with thick acid-resistant lacquers are also in use.

- Quantities are usually 0.5 – 5 liters. Large quantities may be packaged in wooden barrels, Al barrels, large stainless steel tankers for road or rail transport.
- Soft drinks are usually packaged in glass bottles similar to beer, but the glass does not have to be colored.
- Ready-to-drink squashes are packaged in waxed or polythene laminated paperboard cartons. Plastic (polystyrene) containers may also be used.
- Squashes are susceptible to flavor loss hence have a short shelf life.
- Heat processed fruit juices such as nectars and purees are packaged in metal cans lacquered with an acid resistant lacquer.

Baked products Packaging of baked products is as summarized in Table 5.

Table 7: Packaging of Baked Products Product Packaging Standard breads To protect crumb from staling and dehydration. Material should not be impervious, otherwise crust will soften quickly leading to mould growth. Use waxed paper or regenerated cellulose. Polythene is currently in use. Cakes Have high equilibrium relative humidity at room temperature hence tend to dry out. Package in semi-permeable films e.g. QSAT and MSADT. Impermeable materials such as MSAT and MxxT can also be used. Biscuits The equilibrium relative humidity at room temperature is about 5% hence liable to moisture pick-up from the atmosphere. Susceptible to oxidative rancidity and is affected by light. Also friable. Use waxed paper or MSAT plasticized cellulose for flexibility. Use MxxT, which has a more abrasion resistance. In the tropics, these cellulose films require lamination with Al foil or using double the amount of wrapping film and packing, the film-wrapped biscuit in a paperboard carton, which is then over-wrapped with polythene.

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